

IV. ENVIRONMENTAL DATA

Sampling and Analysis

The reaction of acetylene with cuprous salts to form copper acetylide was first used by Berthelot [55] in 1862 to develop an analytical method for acetylene. Berthelot's method was simplified and improved upon by Ilosvay, [56] and later by Treadwell, [57] who developed the gravimetric analytical procedure known as the Ilosvay test. In this procedure, trace quantities of acetylene were determined by shaking gas mixtures in a glass-stoppered cylinder or separatory funnel with a reagent made by adding concentrated ammonium hydroxide solution and hydroxylamine hydrochloride to cupric nitrate in water. The presence of acetylene was indicated by the formation of a red precipitate. The precipitate was then filtered, washed, treated with nitric acid, ignited, cooled, and finally weighed as copper oxide. Calculations were performed on the assumption that $(\text{Cu}_2\text{C}_2\text{H}_2)\text{O}$ (sic) was formed. [58]

Other analytical methods developed were based on a colorimetric evaluation of the red color of copper acetylide formed in Ilosvay reactions. Weaver [59] compared the red cuprous acetylide with either ruby glass slides or colored mixtures of dyestuffs. Schulze [60] passed the gas sample through a cuprous ammonium solution until the depth of color matched that of a previously prepared standard, and Riese [61] prepared his standards by adding a cuprous solution to a dilute aqueous solution of acetylene.

Coulson-Smith and Seyfang, [62] in 1942, raised the following objections to these three colorimetric methods: the dyes used by Weaver

were not readily available; Riese did not consider the solubility changes of acetylene at varying temperatures and pressures; and Schulze's procedure was erroneous because of incomplete diffusion. All three methods had a further drawback in that the gelatin used as a protective colloid caused considerable froth, which made color comparisons difficult or impossible.

Coulson-Smith and Seyfang [62] developed a colorimetric method that reduced these drawbacks. Their procedure involved a comparison in Nessler tubes between the depth of color produced by standard ferric alum solutions in an excess of potassium thiocyanate, and the depth of color produced by 100 ml of acetylene-air standards (ranging from 200 to 2,500 ppm v/v) that had been passed through cuprous ammonium chloride solutions. The resulting cuprous acetylide solutions were visually matched to the corresponding iron standards. The depth of color in the cuprous acetylide solutions bore a linear relationship to the concentration of acetylene within the concentration range of 200-2,500 ppm (v/v) acetylene-air mixtures. This method of analysis was reported by the authors to be accurate to within ± 100 ppm for mixtures with an acetylene content of 200-1,500 ppm (v/v), and to within ± 200 ppm for concentrations of up to 2,500 ppm (v/v) when a 100-ml sample was used. Modifications of this experimental procedure for determinations of acetylene in air at concentrations of 10,000-30,000 ppm were also established. [62] The authors stated that this method of analysis proved very satisfactory within the listed concentration ranges, even when reagents had been previously prepared. Geissman et al [63] pointed out two significant limitations to this method. First, there was a difference in color tone between colloidal cuprous acetylide and ferric thiocyanate that made color matching at the lower concentrations difficult.

Second, if the rate of gas passage, ie, the time of contact between the gas and the reagent, was not properly controlled in all determinations, the results would not be reproducible.

A variation of the Ilosvay test was developed by Geissman et al [63] to determine trace amounts (1-15 ppm) of acetylene in the air. Their method was based on the use of a liquid-air trap to condense acetylene from large volumes of air passed through the trap, and it improved upon earlier methods by using a colorimeter to measure color intensity and closed-container agitation of air-acetylene mixtures to reduce errors in absorption rates. Any acetylene thus concentrated reacted with a modified Ilosvay reagent to form a red precipitate which could be determined in a colorimeter equipped with a 515- μ m filter. The authors determined the precision of the method to be $\pm 0.1-0.5$ ppm over the concentration range of 1.0-15.0 ppm. In addition, sample flowrates of no more than 4-6 cu ft/hr were recommended. This was to ensure that no detectable acetylene would escape condensation before a 0.3- to 0.6-ml sample could be obtained. Because of the time and equipment required to obtain a sufficiently large sample, the method is rather impractical for establishing environmental limits in an industrial setting. Since the coils used in the liquid-air trap are made of copper, any copper salts which are present will react with the acetylene to give erroneous results.

A more rapid and accurate colorimetric method for detecting and measuring concentrations of acetylene in air as low as 10 ppb was developed in 1959 by Hughes and Gorden. [64] The required equipment was simple and portable. Acetylene from air was concentrated on silica gel by adsorption, and the gel surface was then treated with a solution of cuprous ammonium

chloride. The exact acetylene content was established by a visual comparison of the treated sample tube to other tubes that had been previously treated with the same reagent, and which contained constant amounts of adsorbed acetylene produced by exposures to known concentrations of the gas. Tubes collected in the field could be treated immediately or stored in liquid nitrogen for up to 48 hours without apparent color loss. If tubes could be returned to the laboratory within 30 minutes, storage in dry ice was possible. This method measured total adsorbed quantities of acetylene as low as 0.012 μg in 12 ml of air (1 ppm). The authors stated that interfering substances for this test were of two types: (1) those that prevented adsorption of acetylene, and (2) those that gave colored compounds with a cuprous ammonium solution. In the first group, water was the substance that caused the most difficulty, but this could be eliminated by the inclusion of a trap cooled to dry-ice temperature and placed before the detector tube. However, this is impractical for field inspections in an industrial setting. The second type of interfering substance was any low molecular weight alkyne that would pass through the trap described above. These interferences occur because the experimental method is not specific for acetylene and will detect any alkyne in which a triple bond occurs at the end of a hydrocarbon chain. Other interfering substances with relatively high vapor pressures, such as hydrogen sulfide and some mercaptans, are not trapped in the dry-ice trap. [65]

Portable acetylene detector tubes provide a quick and simple way to spot check potential exposure areas. These tubes are based on the method of adsorption of acetylene on treated silica gel, as described by Hughes and Gorden. [64] There are presently several manufacturers of these tubes.

[65] Such tubes have been calibrated to the measurable ranges of 3-600 ppm, 50-1,000 ppm, and 500-3,000 ppm. Inaccurate measurement can result because of interference by various hydrocarbons, ammonia, hydrogen sulfide, and carbon monoxide. [65] None of these tubes have yet been certified by NIOSH.

There are several nonchemical, or dry, methods applicable to the sampling and analysis of acetylene mixtures in the range below the lower explosive limit (LEL). [66] Of these, the portable combustible gas meter equipped with a flash arrester to prevent flashback is the most commonly used detection method in the field. Some of these instruments are based on the reaction of a heated filament in contact with combustible gases. The filament is heated to operating temperature by the passage of an electric current. When the gas sample contacts the heated filament, combustion on the filament surface raises the temperature in proportion to the quantity of combustibles in the sample. A Wheatstone bridge circuit, with the filament as one arm, measures the current caused by the temperature change, which is proportional to the percentage of combustibles present in the sample. [67] Obviously, this method is not specific for acetylene, but it is practicable for field inspections and can be used to spot check for potential occupational exposure in areas where the presence of acetylene, or acetylene mixtures, might pose a fire or explosion hazard. One minor drawback of the combustible gas meter is that, in the absence of sufficient oxygen to allow combustion, readings would be inaccurate.

In recent years, gas chromatographic sampling and analytical methods of suitable specificity and sensitivity for acetylene determinations have been developed. [68] The gas chromatograph used in these analytical

procedures normally consists of three parts: a chromatographic column, a detector, and a recording system. Samples of gas mixtures are separated into their constituents when passing through the column, owing to their different retention times on the column material. Once this separation has been effected, the detector determines the concentration of each of the mixture constituents; this information is then registered by the recording system. Gas chromatography is specific and sensitive but poses a serious drawback in that portable systems are not readily available.

Appendices I and II present recommended methods for sampling and analysis based on the use of both a combustible gas meter and gas chromatography. This combination of methods affords maximum warning against any immediate fire or explosion hazards in workplace environments, while at the same time allowing for a later determination of the extent of exposure to acetylene. The procedure is twofold: (1) a reading is taken with a suitable combustible gas meter properly calibrated for acetylene; (2) if this reading indicates an acetylene concentration of 1,500 ppm or greater in the workplace environment, employees shall be advised that acetylene is present in elevated concentrations, and at the same time a sample shall be taken to determine the exact extent of the exposure. This requirement applies where combustible gas meters are used to screen exposures. If the combustible gas meter has not been calibrated for acetylene, special procedures shall be implemented where readings are in excess of 1,500 ppm. This level of 1,500 ppm was chosen because of the nonspecificity of the combustible gas meter method and because of the need for a rapid monitoring technique below the environmental limit.

Control of Exposure and Hazards

The main objective of engineering design and control measures should be the implementation of safety precautions designed to prevent fire and explosion hazards. There should be adequate engineering controls for dealing with a fire arising in any work location. In addition, in areas where acetylene is manufactured or used, adequate ventilation should be provided to maintain the concentration of acetylene and its impurities (such as phosphine) at safe levels.

Acetylene can be solidified and liquefied with relative ease but, in both states, it may explode with extreme violence when ignited. Thus, the manufacture and use of liquid acetylene should be strictly regulated. [69] Explosive limits and physical properties are listed in Table XII-1. [2-4] Gaseous acetylene may also decompose with explosive force under certain conditions at higher pressures, but 15-pounds-per-square-inch gage (psig) is generally accepted as a safe pressure limit. [70] Generation, distribution through hose or pipe, or utilization of acetylene for welding and allied purposes at pressures in excess of 15-psig or 30-pounds-per-square-inch absolute (psia) pressure should be prohibited. [70]

Work locations and procedures in which acetylene fire and explosion hazards may be prevalent include: large-scale acetylene manufacturing and charging operations; acetylene cylinder handling, transport, storage, and use; small-scale acetylene production from calcium carbide generators; and plants in which acetylene is used for chemical synthesis.

Plants engaged in the generation and compression of acetylene and in the filling of acetylene cylinders, either as their sole operation or in conjunction with facilities for filling other compressed gas cylinders,

should be properly located, constructed, ventilated, and temperature-controlled. Suitable electrical equipment should be used to control flammability hazards. Engineering design for plants compressing acetylene at 15 psig or greater should be in accordance with guidelines for each of the above as presented in NFPA No. 51A-1973. [71, R Lenhard, written communication, May 1976]

Proper plant design guidelines for reducing explosion hazards, based on predicting the possible explosion force in acetylene systems, were presented in an experimental study by Sargent. [72] The intent of the study was to estimate the predetonation distance for acetylene-manufacturing systems. Detailed specifications and safety measures written for a particular plant operation run by the British Oxygen Company in Maydown, Northern Ireland, contain procedures for ensuring safe operations in a plant producing acetylene from calcium carbide. [73]

Handling and use of acetylene cylinders represent the greatest potential sources of fire and explosion hazards because of the large number of employees involved in such operations. The present federal standard, 29 CFR 1910.102(a), provides that such operations shall be in accordance with the Compressed Gas Association pamphlet G-1. [74]

Small-scale production of acetylene from calcium carbide generators for nonchemical use has diminished with the introduction of acetylene in cylinders. In the synthetic chemical industry, most acetylene-consuming plants are located within 3 miles of acetylene-producing plants, and acetylene is often delivered via pipeline. [7]

The proper operation of generators producing acetylene from calcium carbide for welding and other purposes is detailed in 29 CFR 1910.252(a)(6).

When acetylene is used for chemical synthesis, it is generally present as a gas contained in piping systems. As indicated by data obtained during field visits, most major processes for chemical synthesis which utilize acetylene are currently closed processes. [75(pp 6,8,16)] The main hazards associated with these operations are fire and explosion; thus, acetylene transmission systems should be properly designed to minimize these hazards. The federal standard, 29 CFR 1910.102(b), provides that for piping transfer and distribution of acetylene, systems shall be designed, installed, maintained, and operated in accordance with the Compressed Gas Association pamphlet G-1.3-1959. [76] However, the Compressed Gas Association (R Lenhard, written communication, May 1976) has advised NIOSH that the recommendations contained in this pamphlet only apply to specific conditions, and that one should read the pamphlet carefully and apply the regulations contained therein only to those specific conditions.

V. DEVELOPMENT OF A STANDARD

Basis for Previous Standards

The literature presents several standards applicable to acetylene which have been promulgated by trade associations and professional societies. These standards, which include those published by the American National Standards Institute (ANSI) and the Compressed Gas Association (CGA), primarily refer to appropriate work practices that are designed to minimize hazards associated with the flammable and explosive properties of acetylene. In 1965, the Threshold Limits Committee of the American Conference of Governmental Industrial Hygienists (ACGIH) considered the addition of acetylene to Appendix E of their publication, which classifies some gases and vapors as simple asphyxiants. These substances are so classified because of their action when present in high concentrations in the workplace atmosphere and because they lack other significant physiologic effects. Acetylene was included in the ACGIH's Appendix E in 1970. [77] A threshold limit value (TLV) was not recommended at that time because acetylene was deemed to be nontoxic if the oxygen content in the acetylene-air mixture was above 18% by volume under normal atmospheric pressure (equivalent to a partial pressure, pO_2 , of 135 mmHg). Similarly, the Hygienic Guide Series, published by the American Industrial Hygiene Association, [2] recommended that no formal or official maximal atmospheric concentration be assigned to acetylene because of its lack of toxicity.

The present federal standard for acetylene is stipulated in 29 CFR 1915.11(a)(2) which sets a workplace environmental concentration allowable for flammable vapors or gases in any confined space of a ship. This

standard states that, "if tests indicate that the atmosphere in the space to be entered contains a concentration of flammable vapor or gas greater than 10% of the lower explosive limit (LEL), the space shall be ventilated to reduce the concentration below 10% of the lower explosive limit before men are permitted to enter." On the basis of this standard, the maximum allowable environmental concentration for acetylene is 2,500 ppm (1/10 the LEL of 25,000 ppm). The 1/10 factor appears to be arbitrary and is used solely with the intent of providing an adequate safety margin for preventing fire and explosion.

Basis for the Recommended Standard

Recommended environmental limits for airborne levels of acetylene based on health hazards other than indirect production of asphyxia have not been found in the literature. No chronic low-level toxicity studies have been found. In fact, no reports were found on biologic effects of acetylene at concentrations below 100,000 ppm. Acetylene is hazardous at concentrations below 100,000 ppm because of its flammable and explosive properties. The existing federal standard (29 CFR 1915.11(a)(2)) stipulates that the maximum allowable environmental concentration of acetylene in the confined space of a ship shall be 10% of the lower explosive limit (LEL). This standard is appropriate for all workplace environments since the maximum allowable concentration is well below the acetylene concentration at which anesthesia occurs, as well as below the concentration at which the flammable and explosive properties of acetylene present a hazard. It is therefore recommended that the present federal standard be made the basis for an acetylene environmental standard in all

workplace environments.

Because of the toxicity of some impurities, especially phosphine, arsine, hydrogen sulfide, and methyl acetylene, and combustion products of commercial grades of acetylene, it is important that compliance with federal standards applicable to these substances be ensured.

VI. WORK PRACTICES

Acetylene has not been shown to be toxic when present in concentrations below 100,000 ppm (see Chapter III). However, there have been reports in the literature of toxic effects caused by contaminants associated with the production and use of acetylene. [32-34,37] Good work practices must therefore be oriented toward minimizing these toxic hazards and any others that might be present in the workplace environment.

The Compressed Gas Association Commodity Specification for Acetylene [12] established a grading system for identifying and quantifying phosphine, arsine, and hydrogen sulfide content in commercial grades of acetylene. This grading system is given in CGA pamphlet G-1.1 and is illustrated in Table XII-3. It must be noted that if these contaminants present in commercial grades of acetylene are released from the cylinder, there is a possibility that airborne concentrations of these contaminants might exceed present federal limits. Therefore, on the basis of good work practices, it is strongly recommended that a statement of qualitative and quantitative analyses of cylinder contents be made a part of all labeling for acetylene containers, or that the employer use other means, at least as efficient, to convey to the employee such analytical results. It is also recommended that the federal standards applicable to these contaminants be considered and adhered to.

Safe work practices for the production and use of acetylene are the subject of a considerable body of literature. [13,69-73,76,78-87] Most of these references are concerned with the implementation of safety procedures and safety controls designed to protect employees from the occurrence of

fire and explosions. The four main industrial environments in which potential exposure to a flammable atmosphere created by the presence of acetylene might exist are: (1) plants for production of acetylene from small-scale calcium carbide generators, (2) plants for large-scale production of acetylene for chemical synthesis or acetylene cylinder charging, (3) areas in which there is transmission of acetylene via piping or hose systems, and (4) workplace areas which involve the handling, use, and storage of acetylene cylinders.

(a) General Considerations

Because of the flammability and explosibility of acetylene, bans on smoking, or introducing any other source of ignition, or causing any form of ignition shall be strictly enforced in all areas where acetylene is produced, used, handled, or stored. Signs relating to these safety precautions are mentioned by other standard-setting associations. [71,78,82]

Employees should be informed of the rules applying to normal operation of acetylene equipment and of the measures to be taken in the event of accidents. [13] Combustible gas meters equipped with suitable flash arresters and personnel trained in the proper use should be available for spot checking for acetylene leaks in any of the systems in use. [67]

Self-closing metal waste receptacles shall be provided for greasy, oily rags and other such waste materials.

Exits, ventilation ducts, and fire protection equipment shall be easily accessible and obstruction free.

Firefighting equipment shall be conspicuously identified and located to be readily visible and accessible in an emergency.

Before any repair work is attempted on a container or pipe which has contained acetylene, care should be taken to ensure that all such systems have been well purged, either by filling with water or by purging with an inert gas, such as nitrogen. [76]

In the presence of water vapor or certain contaminants, acetylene is likely to react with the following substances to form explosive acetylides: bromine, fluorine, iodine, potassium, and cobalt; copper, mercury, silver, and any salts of these metals; hydrides of sodium, cesium, and rubidium. [88] Therefore, contact between any of the above substances and acetylene shall be strictly prohibited.

Because of the potential formation of acetylides when acetylene is in contact with copper, recommendations have been reported in the literature [2,13,69,71,78,82,89] for the maximum percentage of copper permitted in alloyed metal potentially exposed to acetylene. These maximum limits range from 50% copper in the Matheson Data Sheets [89] to 70% copper in international codes. [69,82] It is recommended that containers, pipes, or metal parts or pieces of machinery made of copper or of alloys containing more than 50% copper should not be used if the material is potentially exposed to acetylene, unless such alloys have been found to be safe in the specific application by experience or by test. The use of unalloyed copper piping for acetylene shall be prohibited; instead, steel or wrought iron is strongly recommended.

All major equipment and piping employed in acetylene operations shall be electrically continuous and bonded to a grounding electrode, as defined by the National Electrical Code, in 29 CFR 1910.308-309.

Generators, compressors, and safety relief devices for acetylene use should be plainly marked with their capacities, pressure ratings, the manufacturers' names and addresses, and model or serial numbers. The capacity and operating pressure of this equipment should not exceed the rating for which it was designed. [82]

Acetylene should not be generated, piped (except in approved cylinder manifolds), or utilized at a pressure in excess of 15 psig pressure (1 atmosphere gage pressure) or 30 psia pressure (2 atm absolute pressure). [70]

(b) Production of Acetylene from Small-Scale Calcium Carbide
Generators

Generators should be of an approved design and be operated only according to the manufacturer's instructions.

Generators should not be operated at more than the rated capacity. Only calcium carbide of correct size and grading should be used in such operations in order to allow control of acetylene-generation rates.

Good work practices should be followed when generators are replenished with carbide, when spent carbide residue is emptied, or during maintenance procedures to diminish the hazards of fire and explosion, and to ensure proper oxygen levels in the atmosphere.

Before any repairs are attempted, the generator should be completely filled with water and then drained. The emptying of carbide residue into a sewer or drain shall be avoided; instead, such residue shall be disposed of in a specially constructed pit or in some other suitable manner.

Hydraulic seals should be checked daily before commencing work and after any flashback, and the water level should be adjusted if necessary.

Only water, at a temperature not to exceed 130 F (54 C), or nonignition-producing equipment shall be used to thaw a frozen pipe or valve.

(c) Large-Scale Acetylene Production and Cylinder Charging

Such acetylene operations should be in accordance with NFPA-51A. [71] The present federal standard for the design and construction of plants engaged in the generation and charging of acetylene cylinders is 29 CFR 1910.102(c), which is the standard prescribed in the Compressed Gas Association Pamphlet G-1.4-1966. However, NIOSH was informed by the Compressed Gas Association (R Lenhard, written communication, May 1976) that Pamphlet G-1.4-1966 was obsolete and was superceded by NFPA-51A.

Rules for the use and maintenance of acetylene generators shall be obtained and shall be conspicuously posted.

(d) Transmission of Acetylene in Piping or Hose Systems

Such acetylene operations should be in accordance with the present federal standard 29 CFR 1910.102(b) which is based on Compressed Gas Association pamphlet G-1.3-1959. [76] This standard shall be used only for the special circumstances mentioned in this pamphlet which include transmission of acetylene between the source of production and the use point, and only under pressures stipulated therein (R Lenhard, written communication, May 1976). It is recommended that piping systems be constructed of material that will withstand the high pressures that may exist in such operations.

Rules and instructions covering the operation and maintenance of acetylene distribution piping systems should be readily available to employees.

The surface temperature of acetylene-containing pipelines shall not be allowed to exceed 130 F (54 C). Aboveground piping systems should be marked in accordance with the Scheme for the Identification of Piping Systems, ANSI Standard A13.1. [81]

Hoses for acetylene should comply with the Specification for Rubber Welding Hose, 1965, issued by the Compressed Gas Association and the Rubber Manufacturers Association. [81] The use of metal-clad or armored hose is not recommended, but, if used, the metal reinforcement must not be exposed to either the inside gas or the outside atmosphere. Hose connections should comply with the Standard Hose Connection Specification, 1957, issued by the Compressed Gas Association.

(e) Handling, Use, and Storage of Acetylene Containers

Such procedures shall be in accordance with the present federal standard 29 CFR 1910.102(a) which is based on Compressed Gas Association pamphlet G-1. [74] It is recommended, however, that Compressed Gas Association pamphlet P-1 [90] be used for such procedures since additional information is contained in this pamphlet. In addition, there is a substantial body of literature on safety practices for protecting against the fire and explosion hazards of acetylene stored in containers. [70,78-80,82-84,86,87]

Acetylene cylinders shall always be used with the valve end up to prevent escape of acetone solvent. The temperature of the cylinder contents shall not exceed 130 F (54 C).

Only cylinders that meet the US Department of Transportation (DOT) Specifications 8 or 8AL (49 CFR Parts 171-179) and the requirements for fillings of a porous material and a suitable solvent are authorized by DOT

for use with acetylene. Only acetylene cylinders which are suitably protected from any contact with hot metal slag or sparks shall be used in any welding or cutting operations.

Acetylene cylinders in permanent storage shall be separated from oxygen cylinders, reserve stocks of carbides, or highly combustible materials by a minimum of 20 feet (6.1 m) or by a noncombustible barrier at least 5 feet (1.5 m) high having a fire resistance rating of at least 1/2 hour. Acetylene cylinders shall be stored in assigned areas where they will not be knocked over or damaged by passing or falling objects. In addition, they shall be stored away from elevators, stairs, or gangways, and away from radiators and other sources of heat. Storage of no more than 2,000 cu ft (56 cu m) of cylinder acetylene should be allowed inside a building when a storage area is within 100 feet (30.5 m) of other acetylene storage areas not protected by automatic sprinklers. Acetylene cylinders shall be secured to prevent them from toppling over.

When acetylene cylinders are coupled, approved flash arresters shall be installed between each cylinder and the couples blocked. When no more than three cylinders are coupled for outdoor use, one flash arrester installed between the couples block and regulator is suitable.

Cylinders in excess of 40 pounds (18 kg) total weight should be transported on a hand or motorized cart. Valve caps should be kept in place except when the cylinders are in use or are connected and ready for service. [81] All cylinder valves shall be closed after use. Where a special wrench is required, it should be left in position on the stem of the valve while the cylinder is in use so that the acetylene may be quickly turned off in case of emergency. In the case of coupled cylinders, at

least one such wrench should be readily available. [81]

Fire watchers should be utilized whenever welding or cutting with acetylene is performed in locations where other than a minor fire might develop. Fire watchers shall be trained in the use of fire extinguishing equipment and be familiar with facilities for sounding a fire alarm. They shall watch for fires, try to extinguish them when feasible, or otherwise sound an alarm. A fire watch shall be maintained for at least one-half hour after completion of welding or cutting to detect or extinguish possible smoldering fires. [81]

VII. RESEARCH NEEDS

No reports have been found that revealed acute or chronic biologic effects of acetylene at concentrations below 100,000 ppm. In addition, no studies have been found on the biotransformation of acetylene in humans or animals. Thus, two areas in which research is needed are: (1) chronic inhalation studies using acetylene at concentrations reflecting environmental exposures, and (2) biotransformation studies using radioactively labeled acetylene.

The main objective of the chronic inhalation studies would be to determine if long-term exposure to acetylene might be associated with systemic toxicity, carcinogenesis, mutagenesis, teratogenesis, or other effects on reproduction. Biotransformation studies might provide information on the production of metabolites of acetylene which could produce some of the biologic effects mentioned above. An epidemiologic study of employees involved in the production and use of acetylene, with emphasis on possible biologic effects, would permit a statistical evaluation of the population of employees occupationally exposed to acetylene.

In the area of work practices associated with acetylene production and use, further research is needed to determine the nature and amounts of impurities present in commercial acetylene and its products of combustion. Chronic inhalation studies should also be performed to determine the toxicity of these impurities and combustion products.

NIOSH strongly encourages industry to find suitable means to remove harmful contaminants, such as arsine, from commercially available acetylene to alleviate the hazards to which users of acetylene may now be subjected.